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US 3837323 A

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(54) Pump with lobed rotors and sealing rods in recesses.

(57) The pump comprises separate rotors 30, 40, out of phase by 90°, within stators 25, 35 and a casing 20. Each rotor has two cam lobes sealed 65, 70 against the inside of its stator and a central fluid passage 75 connected 80 85 to a chamber 140-140''' between rotor and stator that is divided by the rotor lobe seals and holl w sealing rods 110 115 recessed in the stator. Passages 100, 105 connect chambers 140, 140' to chambers 135 and 135'. Fluid flows from prepump 125 through inlet 10 and is delivered to the chambers between the first stator and the casing. Rotation of the shaft 45 causes fluid to be drawn into the chambers between the rotor 30 and stator 25 and, when the chamber closes, fluid is forced into the central passage 75, 75' and on to th second rotor 40 where it flows out between stator and rotor to be forced, by rotation of the rotor, out between the second stator 35 and the casing 20 to outlet 15. Recesses for the sealing rods may be separate from (Figs 2, 3) or combined with (Figs. 5, 7) the passages through the stator wall.

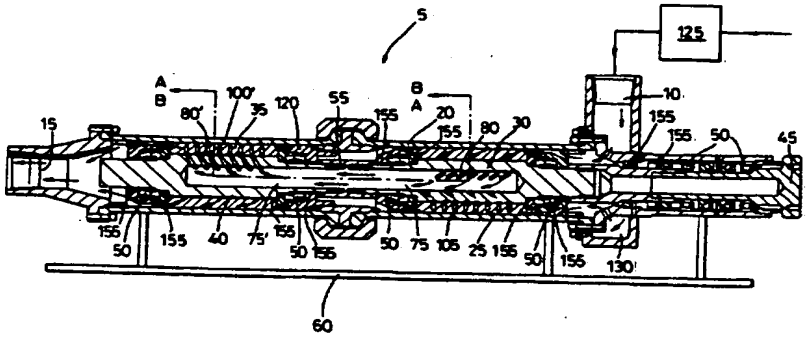

Fig. 1

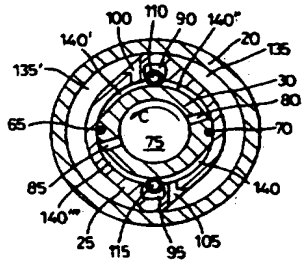

Fig. 2

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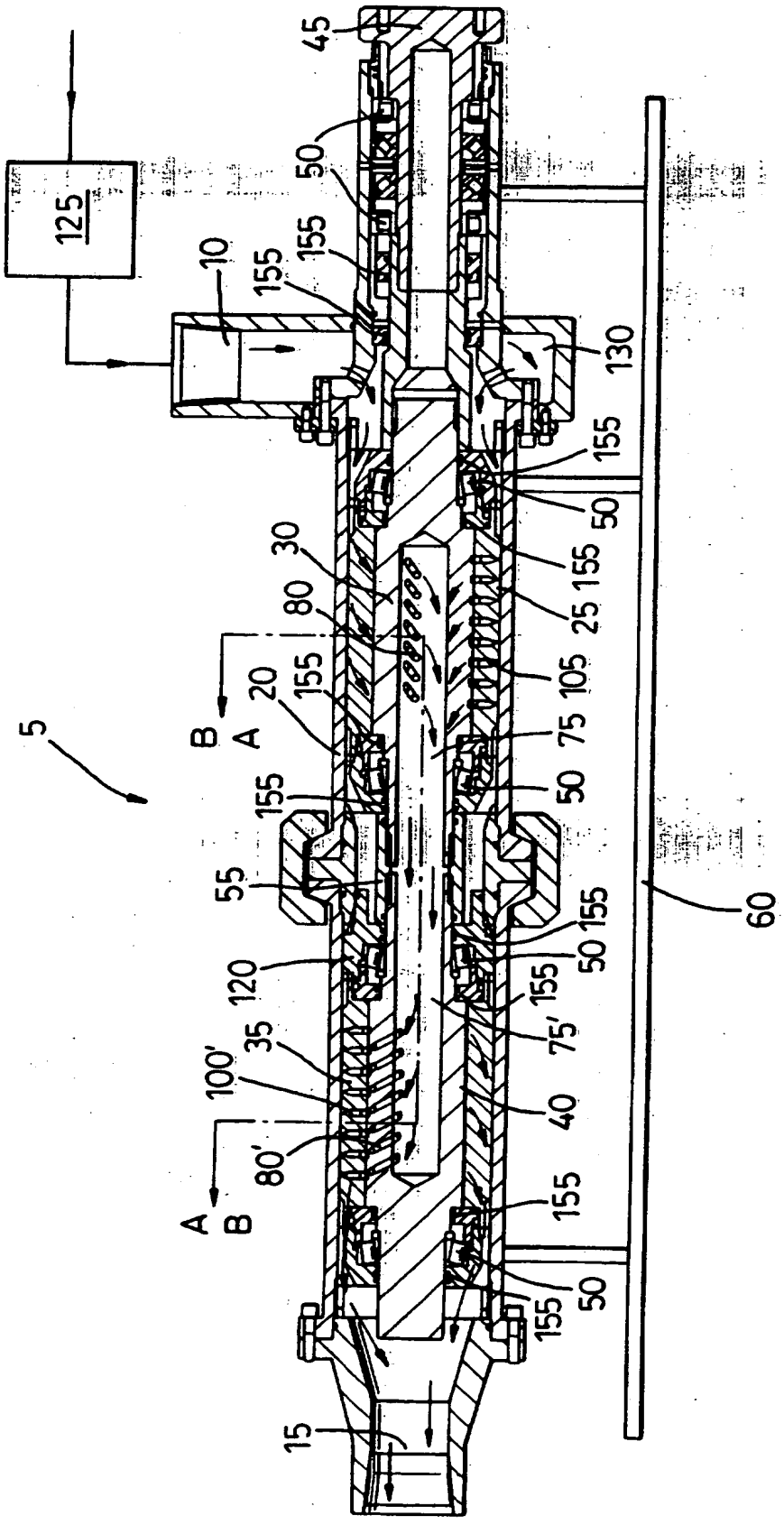

Fig. 1

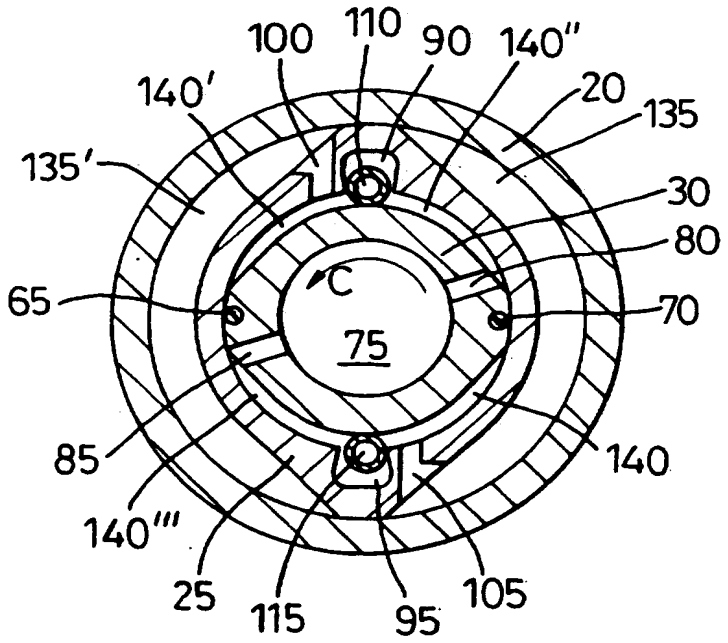

Fig. 2

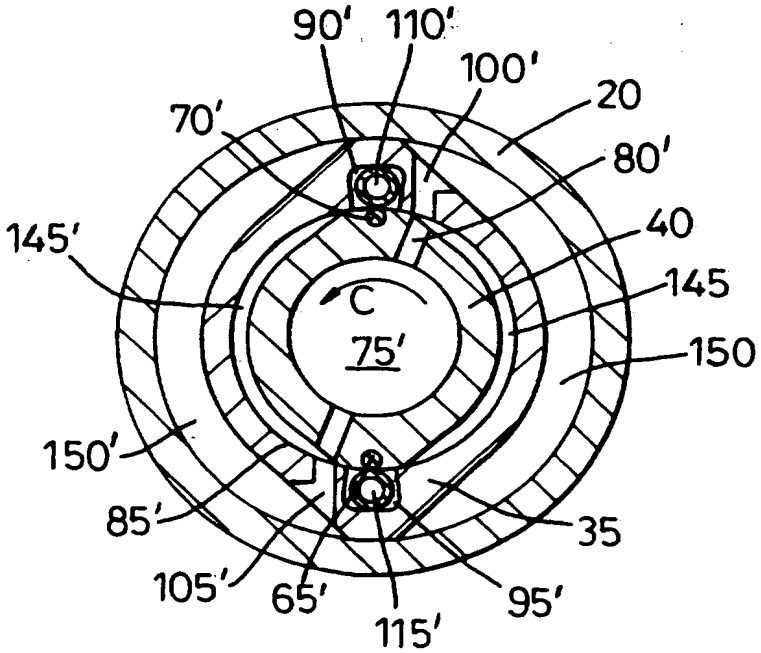

Fig 3

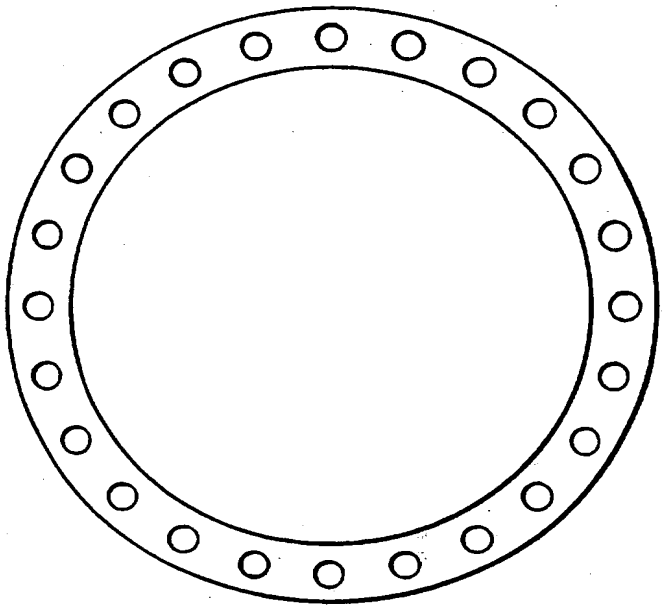

Fig. 4

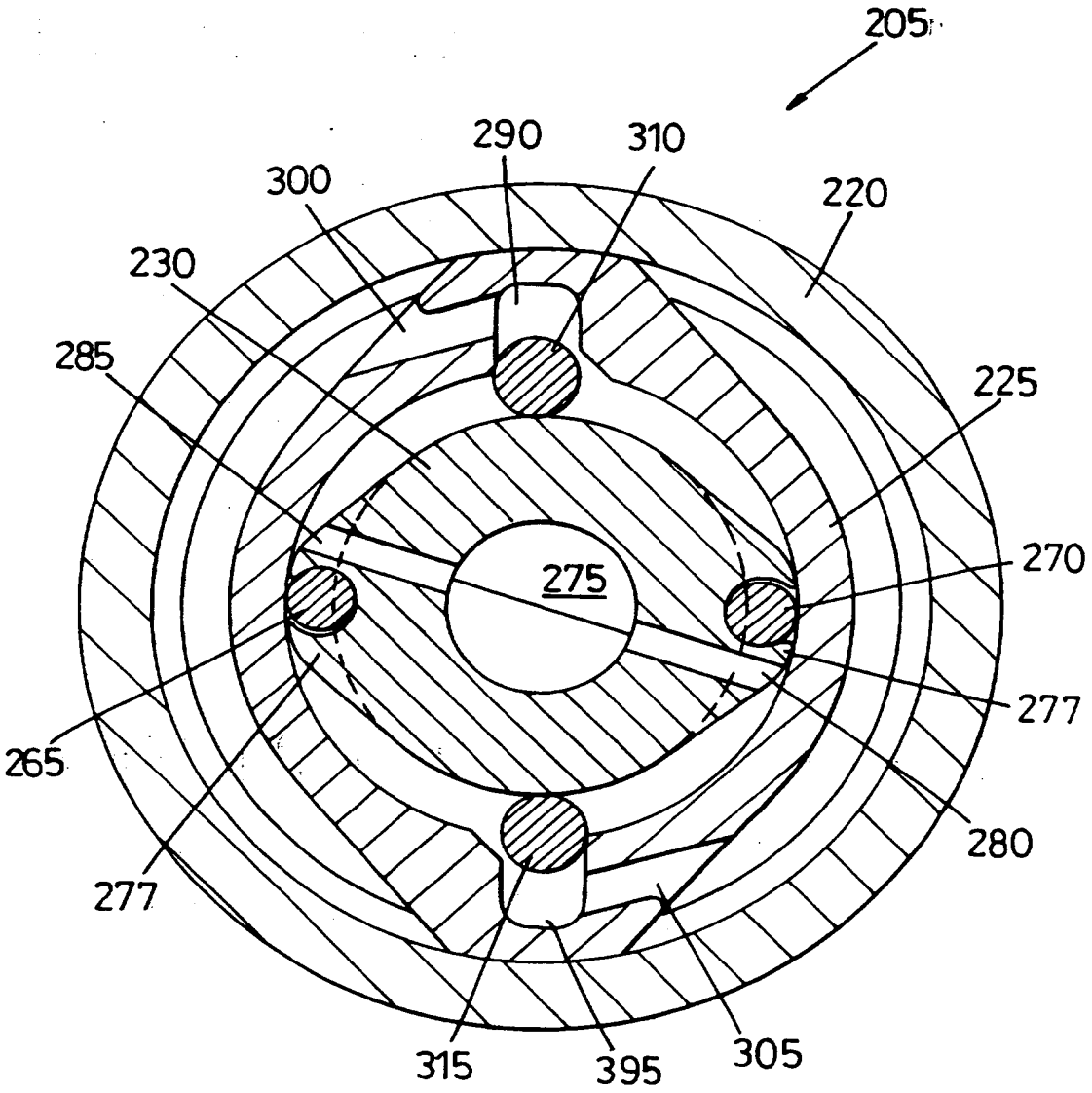

Fig. 5

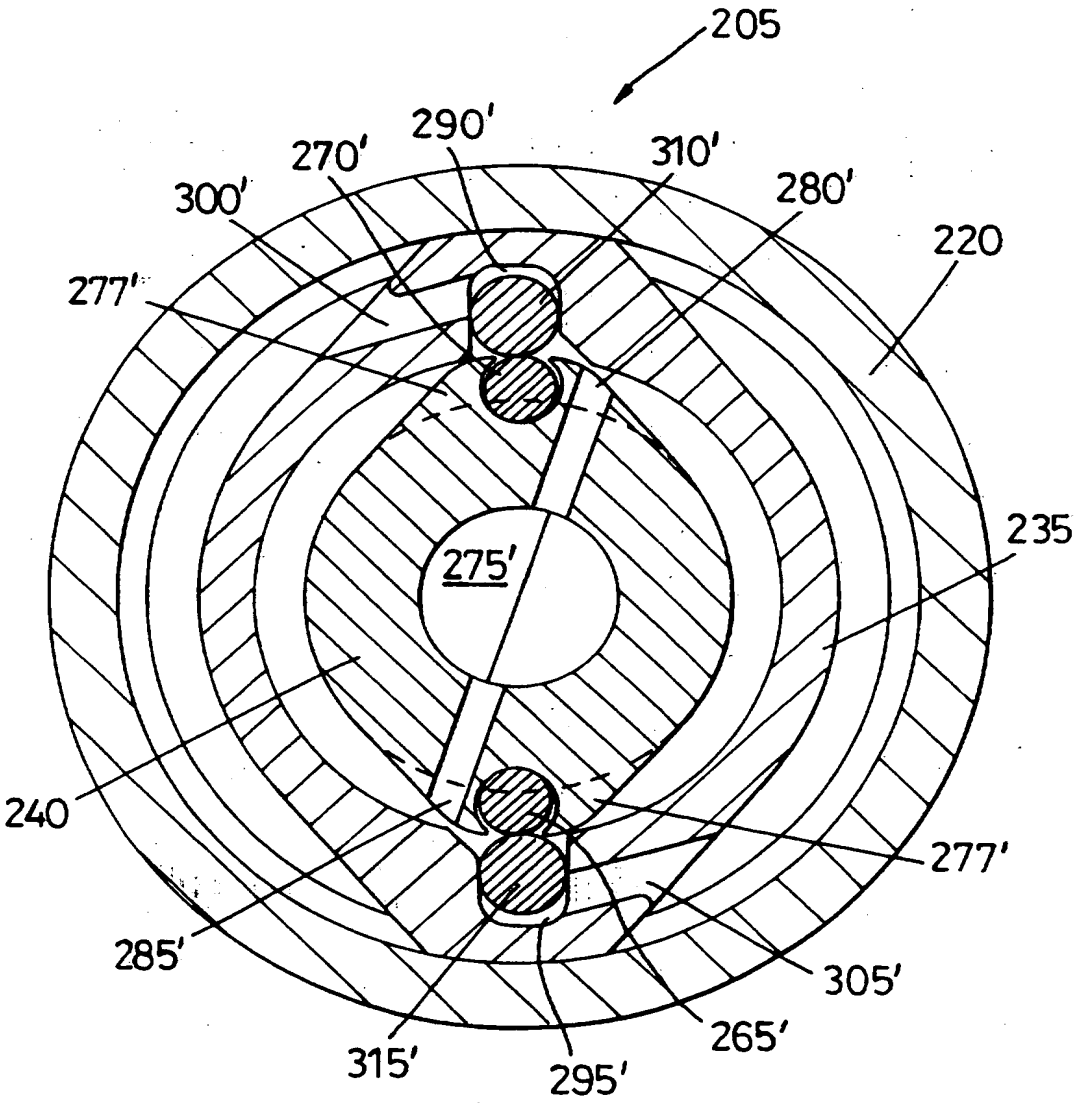

Fig. 6

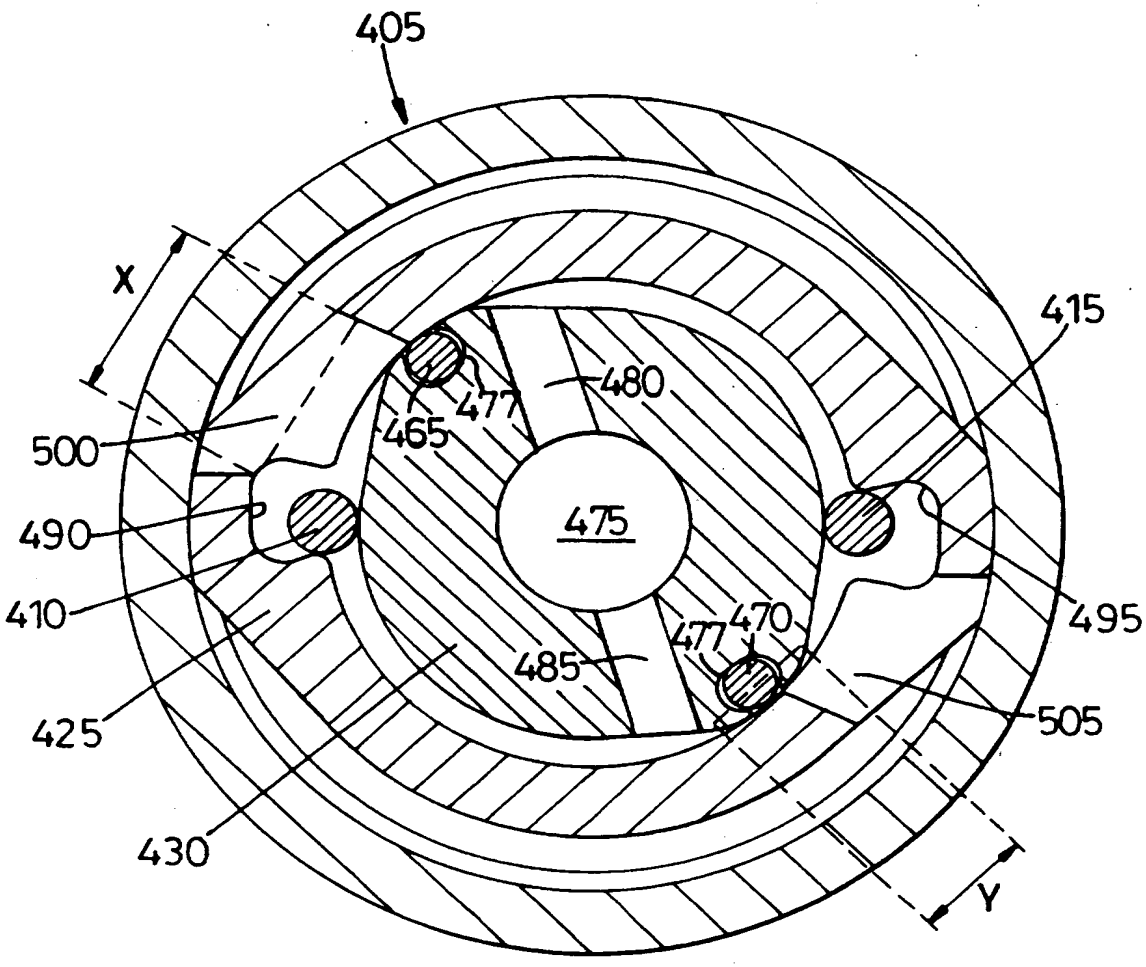

Fig. 7

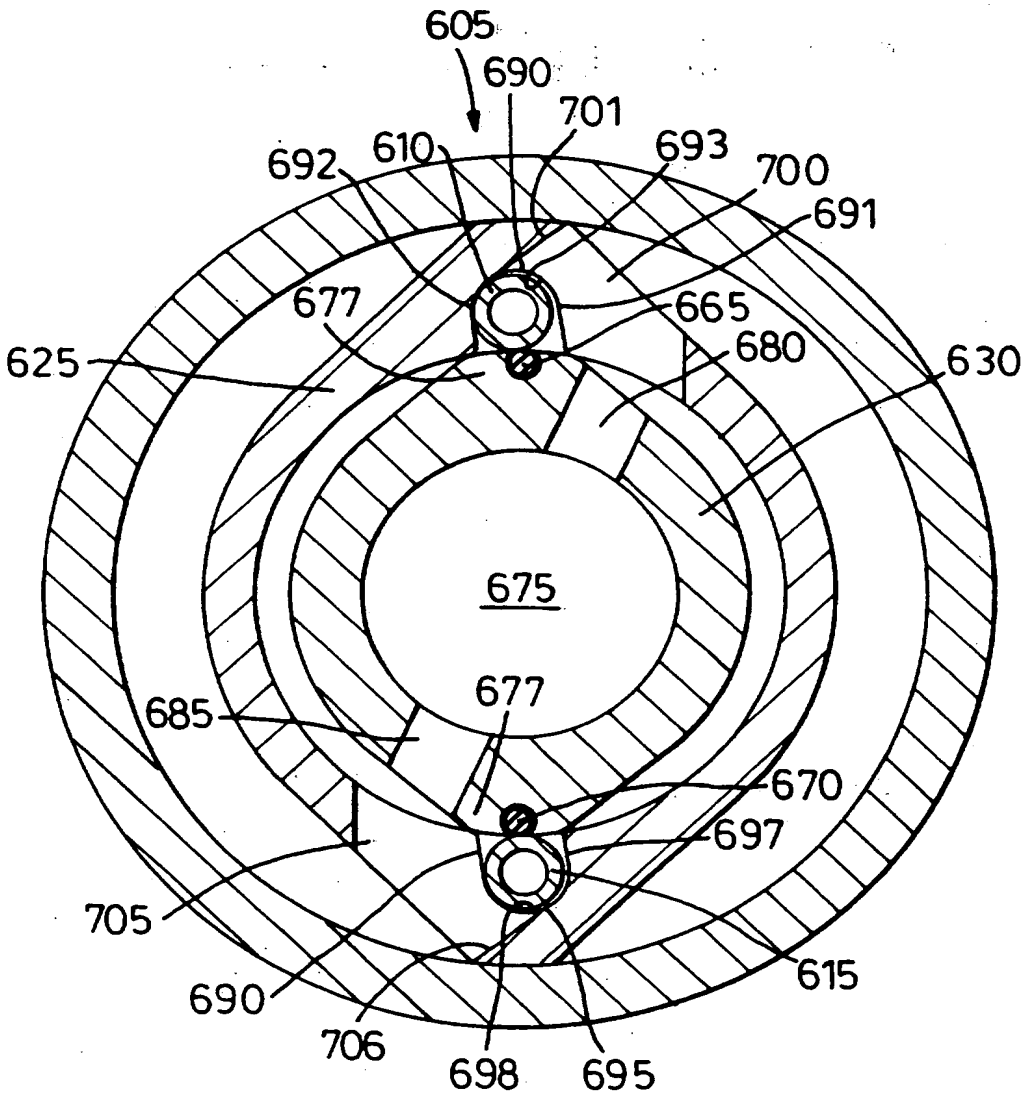

Fig 8

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PUMP

The present invention relates to pumps and in particular, though not exclusively, to pumps used in the oil/gas and chemical industries.

According to a first aspect of the present invention there is provided a pump comprising a casing having at least one inlet and at least one outlet, at least one stator mounted in said casing and at least one rotor rotatably mounted in said at least one stator, means to rotate said rotor(s), said rotor(s) being provided with a rotor channel and at least one port to permit fluid to communicate between said rotor channel and at least one chamber defined between said rotor(s) and stator(s), wherein said stator(s) is/are provided with at least one rod recess and at least one fluid port to permit fluid to communicate between the chamber(s) defined between said rotor(s) and stator(s) and a chamber defined between said stator(s) and said casing, and wherein said at least one rod recess is provided with a rod which, in use, forms a seal between said rotor(s) and stator(s).

Preferably the rotor(s) may be provided with at least one seal for engagement with the stator(s).

Preferably said at least one seal is made from a material selected from the group consisting of plastics materials, polyethylethylketone, metal, copper alloys and stainless steel.

Preferably the rod(s) is/are made from a material selected from the group consisting of plastics materials, polyethylethylketone, metal, copper alloys and stainless steel.

The rod(s) may be hollow.

Preferably said stator(s) is/are provided with two rod recesses which are disposed substantially opposite one another, each of the rod recesses being provided with a respective rod and said rotor(s) is/are provided with two seals which are disposed substantially opposite to one another.

In a preferred embodiment the pump may comprise a first and a second stator with a first and a second rotor rotatably mounted within the respective stators, wherein said first and second rotors are connected to one another.

Preferably an input shaft is connected to the first rotor.

Said rotors may each be provided with a plurality of fluid ports arranged in pairs, each port of each pair being substantially opposite to one another.

Preferably said rotors are connected such that the fluid ports in the first rotor are 90 degrees out of phase with corresponding fluid ports in the second rotor, in use.

Barrier means may be provided between the first stator and the second stator.

The inlet to the pump may be supplied with fluid from a high volume, low pressure charge pump.

According to a second aspect of the present invention there is provided a pump comprising a casing having at least one inlet and at least one outlet, at least one stator mounted in said casing and at least one rotor rotatably mounted in said at least one stator, means to rotate said rotor(s), said rotor(s) being provided with a rotor channel and at least one port to permit fluid to communicate between said rotor channel and at least one chamber defined between said rotor(s) and stator(s), wherein said stator(s) is/are

provided with at least one rod recess formed in an inner surface thereof, the stator(s) providing at least one fluid port communicating between a surface of the at least one rod recess and an outer surface of the stator, said at least one stator fluid port permitting fluid to communicate between the chamber(s) defined between said rotor(s) and stator(s) and a chamber defined between said stator and said casing, and wherein said at least one rod recess is provided with a rod which, in case, forms a seal between said rotor(s) and stator(s).

In a first embodiment of said second aspect the at least one rod recess and rod may further act as a valve which, according to the position of said rotor(s) relative to said stator(s), serves to open and close the at least one stator fluid port.

In a second embodiment of said second aspect the at least one stator fluid port may be adapted such that, in use, rotation of the rotor(s), does not cause the at least one stator fluid port to be closed.

This feature is particularly beneficial in seeking to allow continous flow of drive fluid through the pump, thereby, for example, obviating or mitigating hydraulic hose vibration.

In the second embodiment of said second aspect the at least one stator fluid port may be formed such that at least a portion of the port communicates between a portion of the inner surface of the stator(s) which does not form part of the at least one rod recess and the outer surface of the stator(s).

In a third embodiment of said second aspect a wall of the stator fluid port intersects tangentially with the at least one rod recess.

Preferably opposing walls of the at least one rod recess are substantially parallel to one another.

The base of the at least one rod recess may be substantially the same shape as the at least one rod.

The rotor(s) may be provided with at least one seal for engagement with the stator(s).

Preferably, said at least one seal is made from a material selected from the group consisting of plastics materials, polyethylethylketone, metal, copper alloys and stainless steel.

Advantageously, said at least one rod is made from a material selected from the group consisting of plastics materials, polyethylethylketone, metal copper alloys and stainless steel.

The rod(s) may be hollow.

Preferably, said stator(s) is/are provided with two rod recesses which are disposed opposite one another, each rod recess being provided with a respective rod, and said rotor being provided with two seals which are disposed opposite one another.

In a preferred embodiment the pump may comprise a first and a second stator with a first and a second rotor rotatably mounted within the respective stators, wherein said first and second rotors are connected to one another.

Preferably an input shaft is connected to the first rotor.

Said rotors may each be provided with a plurality of fluid ports arranged in pairs, each port of each pair being substantially opposite to one another.

Preferably said rotors are connected such that the fluid ports in the first rotor are 90 degrees out of phase with corresponding fluid ports in the second rotor, in use.

Barrier means may be provided between the first stator and the second stator.

The inlet to the pump may be supplied with fluid from a high volume, low pressure charge pump.

According to a third aspect of the present invention there is provided a pump comprising a stator and a rotor rotatably mounted in said stator, wherein said stator is provided with at least one combined rod recess and fluid port, said rotor is provided with a rotor fluid port and at least one channel for conducting motive fluid from said rotor channel to a chamber between said rotor and said stator, and said at least one combined rod recess and fluid port is provided with a rod which, in use, may form a seal between said stator and said rotor.

According to a fourth aspect of the present invention two or more pumps according to the first aspect may be arranged with their respective rotors connected together.

Said pumps may be connected in parallel, although they could be connected in series if desired.

Advantageously said pumps may be arranged so that, in use, said pumps operate out of phase with one another. Thus two pumps with two chambers each may be connected 90 degrees out of phase with one another. Similarly, two pumps each with four chambers may be connected 45 degrees out of phase. Arrangements such as these help to ensure a smooth output and inhibit stalling.

The pump according to any of the foregoing aspects may be driven in reverse so as to act as a motor.

Particularly the pump according to the third embodiment of the second aspect may be driven in reverse so as to act as a motor.

Embodiments of the present invention will now be described with reference to the accompanying drawings which show:-

Fig 1. a sectional side view of a pump in accordance with a first aspect of the present invention;

Fig 2. a cross-sectional view at the position indicated by arrow A on Fig 1;

Fig 3. a cross-sectional view at the position indicated by arrow B on Fig 1; and

Fig 4. a view of the bolting arrangement for connecting the outlet to the casing.

Fig 5. a cross-sectional view of a first embodiment of a pump in accordance with a second aspect of the present invention;

Fig 6. an alternative cross sectional view of the motor of Fig. 5;

Fig 7 a cross-sectional view of a second embodiment of a pump in accordance with a second aspect of the present invention; and

Fig 8 a cross-sectional view of a third embodiment of a pump in accordance with a second aspect of the present invention.

Referring to Figs 1. to 3. there is shown a pump generally designated 5, according to an embodiment of the present invention comprising an outer casing 20 having an inlet 10 and an outlet 15, a first stator 25 and a first rotor 30, a second stator 35 and a second rotor 40 and an input shaft 45. The rotors 30,40 are mounted on roller bearings 50 and may rotate within the stators 25,35. The rotors 30,40 are rigidly connected to one another by a connecting member 55 and the first rotor 30 is further connected to the input shaft 45. As with the rotors 30,40, the input shaft 45 is mounted on further roller bearings 5. In the embodiment shown the outer casing 20 is provided with a frame 60 which supports the pump 5 substantially parallel to a surface.

The rotors 30,40 are each provided with a pair of seals 65,65',70 and 70' substantially opposite to one another, a central rotor channel 75,75', and a pair of fluid ports 80,80',85 and 85' positioned substantially opposite to one another. In the embodiment shown the rotors 30,40 are connected such that the groups of fluid ports 80,80',85 and 85' on the first and second rotors 30,40 are 90 degrees out of phase with one another. The stators 25,35 are each provided with a pair of rod recesses 90,90',95 and 95' and a pair of fluid ports 100,100',105 and 105'. The rod recesses 90,90',95 and 95' and pairs of fluid ports 100,100',105 and 105' are provided substantially opposite to one another. The rod recesses 90,90',95 and 95' are further provided with rods 110, 110', 115, 115' which are hollow to reduce their inertia at elevated operating speeds.

The pump 5 is provided with a barrier member 120 at the interface between the two rotors 30,40. The barrier 120 member serves to divide the pump 5 into two halves between which communication is possible only by the rotor channel 75,75' provided within and between the rotors 30,40.

In use, the inlet 10 to the pump 5 is supplied with fluid from a high volume, low pressure centrifugal charge pump 125 and a torque applied to the input shaft 45 which results in the rotation of the rotors 30,40. Fluid passes through the inlet 10 to a volute chamber 130 and then into chambers 135,135' provided between the first stator 25 and the outer casing 20. Fluid then passes through the first stator fluid ports 100,105 and into chambers 140,140' defined by the first stator 25 and the first rotor 30. Rotation of the first rotor 30 in the direction indicated by arrow C (see Fig 2.) results in a increase in volume of chambers 140,140' and hence further fluid is drawn in.

The chambers 140,140' achieve their maximum volume when the first rotor seals 65,70 align with the first stator rods 110,115 and thereafter further rotation of the first rotor 30 results in the obstruction of the first stator fluid ports 100,105, a decrease in the volume of the chambers 140,140' and the introduction of the first rotor fluid ports 80,85 to a boundary of the chambers 140,140'. Thus the fluid present in the chambers 140,140' is forced through the first rotor fluid ports 80,85 and into the first rotor channel 75. It will be apparent that, due to the configuration of the pump 5, it is possible for the filling and discharging of chambers defined between the first rotor 30 and first stator 25 to occur simultaneously. Fig 2. shows the first rotor 30 in a position where the volume of chambers 140,140' is increasing and hence fluid is being drawn in, while the volume of chambers 140'',140''' is decreasing and fluid is being discharged to the first rotor channel 75.

Fluid entering the first rotor channel 75 passes first to the second rotor channel 75' and then to chambers 145,145' defined between the second rotor 40 and the second stator 35 via the second rotor fluid ports 80',85'. As before the rotation of the second rotor 40 first increases the volume of chambers 145,145' and then decreases their

volume and forces fluid through the second stator fluid ports 100',105' and into chambers 150,150' defined between the second stator 35 and the outer casing 20. The fluid then passes to the outlet 15 of the pump 5.

The positioning of the rotors 30,40 90 degrees out of phase with each other prevents backflow of fluid through the pump 5 when the rotor and stator fluid ports 80,80',85,85',100,100',105 and 105' align twice per revolution. The rotors 30,40 and input shaft 45 are further provided with a plurality of seals 155 to stem leakage paths between components.

It is envisaged that the embodiment of the invention described above, which may represent a 12 inch diameter pump, when coupled to a charge pump delivering fluid to the inlet at between 2 and 3 Bar, will supply fluid at a working pressure of around 140 Bar and at a flowrate of approximately 2200 litres per minute.

Figs 5 and 6 show cross-sectional representations of a first embodiment of a pump, generally designated 205, according to a second aspect of the present invention. Figs 5 and 6 correspond respectively to the views indicated by arrows A and B on Figure 1.

For ease of reference like numerals are used in Figs 5 and 6 to designate like parts as in the first pump 5 of Fig 1, but prefixed with '2' or '3'. The pump 205 comprises rotors 230, 240 and stators 225, 235. The rotors 230,240 are each provided with a pair of seals 265,265',270,270', a pair of fluid ports 280, 280',285,285', and a central rotor channel 275,275'. The rotors 230, 240 are constructed such that portions housing the seals 265,265,270, 270' are formed into cam lobes 277,277'. The stators 225,225' are further provided with a pair of rod recesses 290,290',295,295', rods 310,310',315,315' and fluid ports 300,300',305,305'. The rods 310,310',315,315', when acted upon by the cam lobes

277,277' serve to close the fluid ports 300,300',305,305' as shown in Figure 6.

The benefits gained from the closure of the fluid ports 300,300',305,305' include increases hydraulic efficiency and a reduced pump start up speed. The pump 205 operates substantially as the pump 5 as described hereinbefore.

Fig 7 shows a cross-sectional representation of a second embodiment of a pump, generally designated 405, according to a second aspect of the present invention. For ease of reference like numerals are used in Fig 7 to designate like parts as in the pump 5 of Fig 1, but prefixed with "4" or "5".

The pump 405 comprises a rotor 430 and a stator 425. The rotor 430 is provided with a pair of seals 465,470, a pair of fluid ports 480,485, and a central rotor channel 475. The rotor 430 is constructed such that portions housing the seals 465,470 are formed into cam lobes 477. The stator 425 is further provided with a pair of rod recesses 490,495 rods 410,415 and fluid ports 500,505.

As is apparent from Fig 7, in this embodiment, the fluid ports 500,505 are formed such that at least a portion of each port 500,505 communicates between a portion of the inner surface of the stator 425 which does not form part of the rod recess 490,495 and the outer surface of the stator 425.

Further, the breadth "X" of each port 500,505 is greater than the breadth "Y" of the portions of the rotor 430 which carry the rods 410,415.

Thus, in use, rotation of the rotor 430, does not cause the fluid ports 500,505 to be closed.

The pump 405 operates substantially as the pump 5 as hereinbefore described.

Referring now to Fig 8 there is shown a cross-sectional representation of a third embodiment of a pump, generally designated 605, according to a second aspect of the present invention. For ease of reference like numerals are used in Fig 8 to designate the parts as in the pump 5 of Fig 1, but prefixed with "6" or "7".

The pump 605 comprises a rotor 630 and a stator 625. The rotor 630 is provided with a pair of seals 665,670, a pair of fluid ports 680,685, and a central rotor channel 675. The rotor 630 is constructed such that the portions housing the seal 665,670 are formed into cam lobes 677. The stator 625 is further provided witha pair of red recesses 690,695, rods 610,615 and fluid parts 700,705.

In the embodiment opposing walls 691,692,696,697 of the rod recesses 690,695 are substantially parallel to one another. Furthermore, the bases 693,698 of the rod recesses 690,695 are substantially the same shape as the rods 610,615. In addition a wall 701, 706 of the fluid parts 700,705 intersects tangentially with the rod recesses 690,695.

The above-noted rod recess 690,695 and fluid port 700,705 combination has the following advantages:

the flow-through area is greatly increased reducing back pressure and pulsation very considerably;

fluid pressure above the rods 610,615 pushes the rod 610,615 down in a much more controlled manner and better scavenging of solids contamination of the rod recesses 690,695 is obtained by fluid flow above the rods 610,615;

the rod recesses 690,695 are of much simpler geometry and give better guidance to the rods 610,615, thus improving its timing and sealing characteristics.

It should be appreciated that the pumps 5, 205, 405 and 605 hereinbefore described, and particularly the pump 605 of Fig 8 may be driven in reverse so as to act as a motor.

The embodiments of the present invention hereinbefore described are given by way of example only, and are not meant to limit the scope of the invention in any way.

Claims

1. A pump comprising a casing having at least one inlet and at least one outlet, at least one stator mounted in said casing and at least one rotor rotatably mounted in said at least one stator, means to rotate said rotor(s), said rotor(s) being provided with a rotor channel and at least one port to permit fluid to communicate between said rotor channel and at least one chamber defined between said rotor(s) and stator(s), wherein said stator(s) is/are provided with at least one rod recess and at least one fluid port to permit fluid to communicate between the chamber(s) defined between said rotor(s) and stator(s) and a chamber defined between said stator(s) and said casing, and wherein said at least one rod recess is provided with a rod which, in use, forms a seal between said rotor(s) and stator(s).

2. A pump as claimed in claim 1, wherein the rotor(s) is/are provided with at least one seal for engagement with the stator(s).

3. A pump as claimed in claim 2, wherein said at least one seal is made from a material selected from the group consisting of plastics materials, polyethylethylketone, metal, copper alloys and stainless steel.

4. A pump as claimed in any preceding claim, wherein the rod(s) is/are made from a material selected from the group consisting of plastics materials, polyethylethylketone, metal, copper alloys and stainless steel.

5. A pump as claimed in any preceding claim, wherein the rod(s) is/are hollow.

6. A pump as claimed in any preceding claim, wherein the stator(s) is/are provided with two rod recesses which are disposed substantially opposite one another, each of the rod recesses being provided with a respective rod and said

rotor(s) is/are provided with two seals which are disposed substantially opposite to one another.

7. A pump as claimed in any preceding claim, wherein said pump comprises a first and a second stator with a first and a second rotor rotatably mounted within the respective stators, wherein said first and second rotors are connected to one another.

8. A pump as claimed in claim 7, wherein an input shaft is connected to the first rotor.

9. A pump as claimed in any preceding claim, wherein said rotors are each be provided with a plurality of fluid ports arranged in pairs, each port of each pair being substantially opposite to one another.

10. A pump as claimed in any preceding claim, wherein said rotors are connected such that the fluid ports in the first rotor are 90 degrees out of phase with corresponding fluid ports in the second rotor, in use.

11. A pump as claimed in any preceding claim, wherein barrier means are provided between the first stator and the second stator.

12. A pump as claimed in any preceding claim, wherein the inlet to the pump is supplied with fluid from a high volume, low pressure charge pump.

13. A pump comprising a casing having at least one inlet and at least one outlet, at least one stator mounted in said casing and at least one rotor rotatably mounted in said at least one stator, means to rotate said rotor(s), said rotor(s) being provided with a rotor channel and at least one port to permit fluid to communicate between said rotor channel and at least one chamber defined between said rotor(s) and stator(s), wherein said stator(s) is/are

provided with at least one rod recess formed in an inner surface thereof, the stator(s) providing at least one fluid port communicating between a surface of the at least one rod recess and an outer surface of the stator, said at least one stator fluid port permitting fluid to communicate between the chamber(s) defined between said rotor(s) and stator(s) and a chamber defined between said stator and said casing, and wherein said at least one rod recess is provided with a rod which, in case, forms a seal between said rotor(s) and stator(s).

14. A pump as claimed in claim 13, wherein the at least one rod recess and rod act as a valve which, according to the position of said rotor(s) relative to said stator(s), serves to open and close the at least one stator fluid port.

15. A pump as claimed in claim 13, wherein the at least one stator fluid port is adapted such that, in use, rotation of the rotor(s), does not cause the at least one stator fluid port to be closed.

16. A pump as claimed in claim 15, wherein the at least one stator fluid port is formed such that at least a portion of the port communicates between a portion of the inner surface of the stator(s) which does not form part of the at least one rod recess and the outer surface of the stator(s).

17. A pump as claimed in any of claims 13 to 16, wherein a wall of the stator(s) fluid port intersects tangentially with the at least one rod recess.

18. A pump as claimed in claim 17, wherein opposing walls of the at least one rod recess are substantially parallel to one another.

19. A pump as claimed in claim 18 wherein the base of the at least one rod recess is substantially the same shape as the at least one rod.

20. A pump as claimed in any of claims 13 to 19, wherein the rotor(s) is/are provided with at least one seal for engagement with the stator(s).

21. A pump as claimed in claim 20, wherein the at least one seal is made from a material selected from the group consisting of plastics materials, polyethylethylketone, metal, copper alloys and stainless steel.

22. A pump as claimed in claim 21, wherein the at least one rod is made from a material selected from the group consisting of plastics materials, polyethylethylketone, metal copper alloys and stainless steel.

23. A pump as claimed in claim 22, wherein the rod(s) is/are hollow.

24. A pump as claimed in claim 23, wherein the stator(s) is/are provided with two rod recesses which are disposed opposite one another, each rod recess being provided with a respective rod, and said rotor being provided with two seals which are disposed opposite one another.

25. A pump as claimed in any of claims 13 to 24, wherein the pump comprises a first and a second stator with a first and a second rotor rotatably mounted within the respective stators, wherein said first and second rotors are connected to one another.

26. A pump as claimed in claim 25, wherein an input shaft is connected to the first rotor.

27. A pump as claimed in claim 25 or 26, wherein Said rotors are provided with a plurality of fluid ports arranged in pairs, each port of each pair being substantially opposite to one another.

28. A pump as claimed in any of claims 25 to 27, wherein said rotors are connected such that the fluid ports in the first rotor are 90 degrees out of phase with corresponding fluid ports in the second rotor, in use.

29. A pump as claimed in any of claims 25 to 28, wherein barrier means are provided between the first stator and the second stator.

30. A pump as claimed in any of claims 25 to 29, wherein the inlet to the pump is supplied with fluid from a high volume, low pressure charge pump.

31. A pump as claimed in any preceding claim, wherein the pump is driven in reverse so as to act as a motor.

32. A pump as claimed in cany of claims 17 to 19, wherein the pump is driven in reverse so as to act as a motor.

33. A stator and a rotor rotatably mounted in said stator, wherein said stator is provided with at least one combined rod recess and fluid port, said rotor is provided with a rotor fluid port and at least one channel for conducting motive fluid from said rotor channel to a chamber between said rotor and said stator, and said at least one combined rod recess and fluid port is provided with a rod which, in use, may form a seal between said stator and said rotor.

34. A pump substantially as hereinbefore described with reference to and as shown in Figs 1 to 4.

35. A pump substantially as hereinbefore described with reference to and as shown in Figs 1,5 and 6.

36. A pump substantially as hereinbefore described with reference to and as shown in Figs 1 and 7.

37. A pump substantially as hereinbefore described with reference to and as shown in Figs 1 and 8.

The Patent Office

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Applicati n N : GB 9703265.0
Claims searched: 1-37

Examiner: J. C. Barnes-Paddock
Date of search: 20 April 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): E1F (FWDMD); F1F

Int Cl (Ed.6): E21B 4/023; F01C 1/04, 34, 356, 19/02, 04; F04C 2/04, 22, 34, 356, 18/04, 22, 34, 356

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
XP	GB 2,297,777	(HOLLANDSCHE) Fig 3a-d Rods in recesses sealing against rotor of an excavator.	1-4,6-11
X: Y	WO 95/19488	(HARRIS et al) Figs 2a-3d Page 7 ll 6- 10, line 24 onward. Rods in recesses sealing against a rotor.	X:1-4,6-11 Y:13,15 20-22 24-29,31 33
Y	WO 94/16198	(GRUPPING) Fig. 2, Page 3, ll 20-25. Rollers sealing against stator, recesses supplied with motive fluid.	13,15 20-22 24-29,31 33
A	US 3,837,323	(DELFINO et al) A stator with radial seals and a rotor having passages.	

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family
A Document indicating technological background and/or state of the art.
P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.